

Exemption No. 5597

**UNITED STATES OF AMERICA
DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
RENTON, WASHINGTON 98055-4056**

In the matter of the petition of

Boeing Commercial Airplane Group

Regulatory Docket No. 26900

for an exemption from §§ 25.562(c)(5) and
25.562(c)(6) of the Federal Aviation
Regulations

DENIAL OF EXEMPTION

By letter B-TOAU-92-365 dated June 5, 1992, John A. Miller, Chief Engineer, Airworthiness, 777 Division, Boeing Commercial Airplane Group, P.O. Box 3707, Seattle, WA 98124-2207, petitioned for an exemption from the Head Injury Criterion (HIC) and femur load limitations of §§ 25.562(c)(5) and (c)(6) of the Federal Aviation Regulations (FAR), for front row seating and cockpit seating in Boeing Model 777 airplanes, until such time as design solutions are available.

Section of the FAR affected:

Section 25.562(c)(5) requires that each occupant must be protected from serious head injury under the conditions prescribed in paragraph (b) of this section. Where head contact with seats or other structure can occur, protection must be provided so that the head impact does not exceed a Head Impact Criterion (HIC) of 1,000 units. The level of HIC is defined by the equation:

ANM-92-027-E

Section 25.562(c)(6) requires that a maximum compressive femur load of 2250 pounds not be exceeded under the same conditions.

Related Section of the FAR:

Section 25.785(a) requires that each seat, berth, safety belt, harness, and adjacent part of the airplane at each station designated as occupiable during takeoff and landing must be designed so that a person making proper use of those facilities will not suffer serious injury in an emergency landing as a result of inertia forces specified in §§ 25.561 and 25.562.

The petitioner's supportive information is as follows:

Passenger seats for the Model 777-200 airplane will meet the requirements of TSO-C127 and the requirements of FAR 25.562 in all respects with the exception of FAR 25.562(c)(5) for seats located aft of bulkhead walls (galley, lavatory, closet, etc..) and for seats aft of emergency escape slide bustle locations. These seats will hereafter be referred to as "front row" seats.

Flight deck seats will meet the requirements of TSO-C127 and FAR 25.562 in all respects with the exception of FAR 25.562(c)(5) for the Captain's and First Officer's seats, FAR 25.562(c)(6) for the First Observer's seat, and the exemption from the seat track misalignment requirements, already granted.

Front row seat issues

Even though a great deal of work has been done since the publication of the rule, the technology to meet the requirements of 25.562(c)(5) for front row seats is not sufficiently developed at this time to support the certification schedule of the Model 777-200 airplane.

Boeing has been pursuing technical solutions to the requirements since mid 1989. Boeing participated in the SAE 16g ad hoc committee's preparation of Aerospace Standard 8049 from late 1987 until its completion in early 1990. Boeing also participated in the AIA TARC activity in assessing the impact of NPRM 86-11 & 88-8. The TARC activity was primarily related to the structures aspects and did not address 25.562(c)(5). Effort for passenger front row seating has been concentrated on the following approaches:

- 1) Shoulder harnesses for front row passengers
- 2) Relocate or remove seats
- 3) Translating seat pans
- 4) Energy absorbing padding
- 5) Air bags

Shoulder harnesses

The airlines have been adamant in their opposition to the introduction of shoulder harnesses for use by front row passengers.

Boeing has contracted with a domestic seat supplier to test a prototype shoulder harness equipped seating system at CAMI. Initial testing conducted in August 1992 resulted in a structural failure. The seat will be modified and restored in late 1992. Further evaluation and testing is expected to continue thru 1993. Boeing is in contact with an international seat supplier in the process of developing and testing a shoulder harness equipped seating system. Boeing is also in contact with aircraft restraint manufacturers in the process of developing shoulder harness restraint systems for passenger seats.

Relocate or remove seats

Testing has shown that a 50th percentile occupant will require a fifty inch setback from a vertical wall. The additional fifteen inches (beyond the present thirty-five inch setback) can not be acquired by simply reducing pitch for the aft seats. Relocating the front row seats will result in the loss of seats which will impose an economic hardship not envisioned when the rule was written. The value of a lost seat is \$182,000 per year in 1992 dollars.

Translating seat pans

Translating seat pans act to convert the forward motion of the occupant to upward motion resulting in reduced contact with the vertical wall.

Proof of concept testing completed by Life Force, Inc. and Boeing at Wayne State University (November 1991) and CAMI indicates that the concept (seat motion) is viable. However, the concept has not yet proven practical for commercial use; further design, fabrication and testing is required.

Boeing has initiated a development contract with a seat supplier to further investigate the concept, and the incorporation of the motion into aircraft seating systems. Results from the development/testing are expected in mid 1993. Boeing is continuing an in-house development program in parallel with the supplier contracted program.

Energy absorbing padding

Testing with energy absorbing pads on vertical walls has been done at the CAMI facility in Oklahoma City working jointly with FAA personnel.

37 dynamic impact sled tests completed at CAMI (May 91 - August 92) indicate that the concept is a possible solution in some locations. However, several problems exist with this solution. Covering materials have not been identified which provide protection and durability to the energy absorbing materials without increasing the HIC level above the allowed 1000 units. Integration of an energy absorbing material with other interior items (ie. literature pockets, video displays, bassinet tables, etc.) is still unresolved. The thickness of the material (Approx. 5") presents egress concerns for the front row passengers. It is unlikely that this solution would be usable for seats aft [of] slide bustle locations without a major redesign of the exit door/slide bustle and interior due to space constraints.

Air bags

Preliminary testing of air bags mounted on vertical wall surfaces has been accomplished. This testing has shown that air bags are a candidate solution. Air bag technology for application in automobiles is well established. Development must still be done to establish pulse requirements, to configure inflation systems and to determine the characteristics for the crash sensors. Boeing has worked with airbag component suppliers (TRW Technar, Talley Defence Systems, and Rocket Research Co.) in developing and testing 1,2, and 3 abreast seating configurations. All tests were conducted at the FAA CAMI Facility between November 1991 and April 1992. A total of 11 dynamic impact sled tests were conducted. Testing to date indicates this concept is viable in providing HIC protection. However, an integrated system is still far from development.

Accordingly, we petition:

For exemption from the requirements of FAR 25.562(c)(5) for front row seats and for seats aft of emergency escape slide bustles for the Model 777-200 airplane.

Grounds for the petition for exemption are:

- 1) Research, development and production of the concepts investigated thus far will not support the delivery schedule for the Model 777-200 airplane.
- 2) Granting of the petition will not impede development of a technically and economically acceptable solution.
- 3) Development and testing efforts for front row passenger protection are underway and will continue.
- 4) When a proper solution has been developed to a production design, Boeing is prepared to work with the airlines to retrofit Model 777-200 airplanes to meet the requirements of FAR 25.562(c)(5).

5) Neither the FAA nor the industry was aware of the implications of FAR 25.562(c)(5) until late 1990.

6) The rule applies at this time only to the Model 777-200 airplane among wide body aircraft, placing it at a competitive disadvantage with European products, which could have an adverse effect on the balance of payments.

When the ability to meet the rule for "front row" seats has been confirmed Boeing will establish production incorporation commitments and will initiate work with the airlines regarding retrofit of already delivered Model 777-200 aircraft.

Flight Deck Crew Seat Issues

With respect to the pilot seats, the requirements of FAR 25.562(c)(5) are in conflict with other requirements concerned with the location of controls and displays in the flight deck, visibility of the primary flight displays, and the pilots' out-the-window vision envelope. Test data acquired from the Civil Aeromedical Institute Test #A91030 indicates that in the crash conditions imposed by the FAR, the pilots' heads will strike the upper aft edge of the glare shield. If the upper side of the glare shield is fitted with additional padding, the pilots' out-the-window forward down vision angle will be significantly compromised. Such compromising affects the safety of the approach and landing and collision avoidance capability maneuvers. If the glare shield is then lowered to accommodate additional padding on its top surface, an interference will occur with the control wheel and the underside of the glare shield when the pilot inputs roll commands. If the aft edge of the glare shield is moved further forward, less shielding of the primary flight displays from intense sun light will be provided and readability of the displays will suffer. Again, padding would be required which would interfere with the pilots' out-the-window vision.

Air bags and back powered inertia reels were evaluated to meet this requirement. Both were considered as undesirable because inadvertent operation restricts the pilot's control of the airplane.

Thus Boeing is unable to be sure it can comply with the combination of these requirements and we petition for an exemption from the requirements of FAR 25.562(c)(5) for the pilots' seats. Boeing will try on a best effort basis to comply with the requirement using normal padding methods without compromising outside vision and operational capability.

With respect of the first observer's seat, Boeing is unable to comply with the requirements of FAR 25.562(c)(6) unless the seat is placed in the aft position for takeoff and landing because of the proximity of the control stand. Placing the first observer's seat in the full aft position may not meet the requirements of FAR 121.581.

Therefore we petition for an exemption from FAR 25.562(c)(6) for the first observer's seat.

In summary:

- 1) Even though a great deal of work has been done since the inception of the rule to develop economically and technically feasible solutions for the front row requirements, there is no acceptable solution available to support certification of front row seats at this time. Thus, an exemption from FAR 25.562(c)(5) is required. Boeing is committed to work diligently to achieve a solution and is prepared to work with the airlines regarding retrofit of delivered airplanes.
- 2) There is no technical solution to the combination of the FAR Part 25 requirements imposed on the pilots' seats. Thus an exemption from FAR 25.562(c)(5) is required.
- 3) There is a conflict between the FAR's Part 25 and Part 121 requirements regarding the first observer's seat which can only be resolved either by placing a restriction on use of the first observer's seat during takeoff and landing or by obtaining an exemption from FAR 25.562(c)(6).

A summary of the petitioner's June 5, 1992, petition was published in the Federal Register on July 15, 1992 (57 FR 31398). Two comments were received.

The first commenter generally supports the petitioner's arguments and notes that the industry is working to solve the problems currently being experienced. The commenter also suggests that an exemption should be granted to all affected transport airplanes.

The second commenter reiterates the safety aspects of the regulation and argues that basic requirements should be maintained. The commenter does allow that a limited time exemption could be acceptable, but stresses that a definite limit should be imposed to ensure rapid development of solutions.

The Federal Aviation Administration's analysis/summary is as follows:

The FAA concurs with the spirit of both comments. At the time of the petition, commercially viable means of compliance with HIC were not available; the industry is working to develop solutions, and several appear to be very viable for commercial use. The FAA also agrees that a definite deadline is required to speed the progress of design solutions, and help ensure that concepts are developed into practical measures as expeditiously as possible.

The FAA has carefully considered the information provided by the petitioner and has determined that there is not sufficient data to warrant granting this petition at this time. The petitioner notes that there are currently many possible solutions

under development, some of which have been tested with satisfactory results. Examples include:

1. Aluminum honeycomb added to bulkheads has been shown to reduce HIC below 1,000. Concerns about its appearance, and the susceptibility of unprotected honeycomb to in-service damage, have driven much of the research in this area. Other materials providing the same characteristics may also be available. The FAA believes that both aspects of the concept should be fully explored before a determination of its ultimate acceptability is made.
2. An upper torso restraint, similar to those currently utilized by flight attendants, would restrain the head from contacting any injurious surface. Concerns of public relations and passenger reaction have been expressed regarding upper torso restraints, as to possible perceptions of an increased level of danger inherent in seats equipped in such a manner (or, conversely, a higher level of safety afforded passengers in seats so equipped.) Recent testing indicates that technical problems can be overcome. The FAA considers technical problems to be legitimate grounds for not pursuing a solution; unsubstantiated claims regarding passenger reaction, however, are not.

The petitioner mentions other examples of possible solutions that may prove to be appropriate for certain design situations. The FAA considers that each technically viable solution must be considered before a grant of exemption is possible. The fact that some solutions may be commercially less desirable is not grounds for an exemption. At the time of the petition, there was, in fact, not much data available to suggest which design solutions might be viable. Since that time, there has been much development, and the FAA believes that several viable solutions should be forthcoming. In fact, exemptions previously granted regarding this requirement expire at the end of 1993.

Implicit in the petitioner's argument is the need to establish design details for the airplane as early as possible. This is due to long lead time for parts, and design and manufacturing considerations. The FAA understands that, at some point, a design must be "frozen" to allow it to be produced in accordance with established schedules. For this reason, it is necessary to not only establish the applicable regulations for a given type design, but to establish the probable means of compliance well in advance of the certification date. The amount of time necessary for this is somewhat variable, depending on the specific design, but a certain lead time is required to change the basic design. For the types of design solutions for HIC likely to be available for the model 777, however, the basic design of the airplane will not necessarily be affected. For example, an energy absorbing pad could be added to an existing bulkhead, with minimal change to the

hardware. A seat incorporating an upper torso restraint can be substituted for a standard seat, with no change to the airplane.

While neither of these solutions is currently ready for production installation, the FAA is encouraged by the pace of developments in these areas. Given the certification date for the 777 (April 1995), the FAA considers that these solutions should be readily available by the time they are needed. Nonetheless, if an insurmountable obstacle is encountered, the FAA will entertain a petition for exemption at that time, provided that there are adequate data to substantiate the request.

While the above arguments pertain primarily to "front row" seats, the same rationale holds for the flight deck. In fact, compliance with the HIC requirements for the flight deck has been achieved for type certification of other models. The need for the pilots to have adequate access to controls and view from the flight deck is acknowledged; however, the petitioner has presented no test data to indicate the severity of problems with HIC or, in fact, that there is a problem. In addition, other design solutions that might mitigate HIC problems, such as a more frangible glare shield, have apparently not been addressed. Both test data and a thorough examination of possible design solutions are necessary before the FAA could grant an exemption.

Regarding the request for exemption from the femur load requirement, the FAA is unaware that there is any problem in this area. In fact, the FAA is unaware of any failure, on any certification test, for this parameter. Since the petitioner has presented no data to support the request, this aspect of the petition is also denied.

In consideration of the foregoing, I find that a grant of exemption is not in the public interest. Therefore, pursuant to the authority contained in §§ 313(a) and 601(c) of the Federal Aviation Act of 1958, delegated to me by the Administrator (14 CFR 11.53), the petition of Boeing Commercial Airplane Group to exempt them from compliance with §§ 25.562(c)(5) and (c)(6) of the FAR is hereby denied. In making this determination, the FAA is not foreclosing on the possibility of an exemption at a later date, if it becomes warranted.

Issued in Renton, Washington, on January 29, 1993.

James V. Devany, Acting Manager
Transport Airplane Directorate
Aircraft Certification Service